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Author: Lukas Eberle Elisabet Capón García Hirokazu Sugiyama Andreas Graser Rainer Schmidt Konrad Hungerbühler



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# Rigorous Approach to Scheduling of Sterile Drug Product Manufacturing

Lukas Eberle<sup>a,b</sup>, Elisabet Capón García<sup>a,\*</sup>, Hirokazu Sugiyama<sup>c</sup>, Andreas  
Graser<sup>b</sup>, Rainer Schmidt<sup>b</sup>, Konrad Hungerbühler<sup>a</sup>

<sup>a</sup>*ETH Zürich, Vladimir-Prelog-Weg 1, 8093 Zürich, Switzerland*

<sup>b</sup>*F.Hoffmann-La Roche Ltd., Grenzacherstrasse 124, 4070 Basel, Switzerland*

<sup>c</sup>*The University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, 113-8656 Tokyo, Japan*

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## Abstract

Optimizing the scheduling of liquid drug product manufacturing is paramount for pharmaceutical companies in their increasingly competitive environment and requires the modelling of industry-specific constraints. Such constraints include: (i) changing sequence-dependent setup times; (ii) maintaining a sterile production environment (e.g., through sterile holding times); (iii) periods with limited or no plant activity (e.g., no workforce during weekends); and, (iv) demand timing (i.e., delivery deadline and release date constraints). In this work, an immediate precedence model is formulated to optimize the scheduling of liquid drug product manufacturing, considering the industry-specific constraints. The primary objective is to minimize the production makespan.

Four case studies comprising up to 38 batches from a real multi-product facility illustrate the performance of the rigorous optimization approach. The makespan could be reduced by up to 7.9 % compared to expert schedules.

*Keywords:*

Mathematical Optimization, Mixed-Integer Linear Programming,  
Scheduling, Batch Production, Industrial Application, Campaigning

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\*Corresponding author: Elisabet Capón García, elisabet.capon@chem.ethz.ch.

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